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## Certificate of Analysis

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Lab No. 724946A (ALTEBO)

Report Date: April 7, 2005

Email: weo\_altinc@bellsouth.net

***Sample Description:*** LAB724946B – New Formula Unused Motor Silk  
Sample: 012705-A

Dear Bill:

Thank you for your confidence in Herguth Laboratories, Inc. Please accept this report and attachments as results to the above numbered project/sample description.

### **Summary and Conclusion:**

The Motor Silk formula showed remarkably low results in the area of coefficient of friction and wear scar as measured using the Pin-On-Disk Tribometer.

The Motor Silk was tested over several runs on the Tribometer to evaluate the wear resistant, film forming characteristics of the product. The runs were carried out over a period of time allowing the Motor Silk to form the wear resistant film. The test results for coefficient were much better as the runs progressed. The final run had a steady coefficient of friction of 0.02.

After the final lubricated run the disk and pin were allowed to drain dry and further testing was performed un-lubricated for 2 hours. Upon examination of the test specimens the original machining (grinding) marks were still visible and the coefficient of friction was a respectable 0.10 (un-lubricated).

Details of the analysis can be seen in the table, graphs and photos of the results.

**Background and Analysis:** The Motor Silk sample # 012705-A was tested using the Pin-On-Disk Tribometer to evaluate wear and coefficient of friction responses. There were four normal one hour runs at 50 Newtons and ambient temperature with continuous oil flow, the first immediately upon wetting with oil, the next two after two hour soak times, and the fourth after a 14.25 overnight soak time. The pin and disk were not removed from the device between runs. These four runs yielded decreasing friction from start to finish of each run.

The fifth run was performed without cleaning the pin or disk, but the pin was rotated to yield a separate scar. This was also run with oil continuously flowing. This was run to yield a steady state coefficient of friction. This occurred after one hour of run time.



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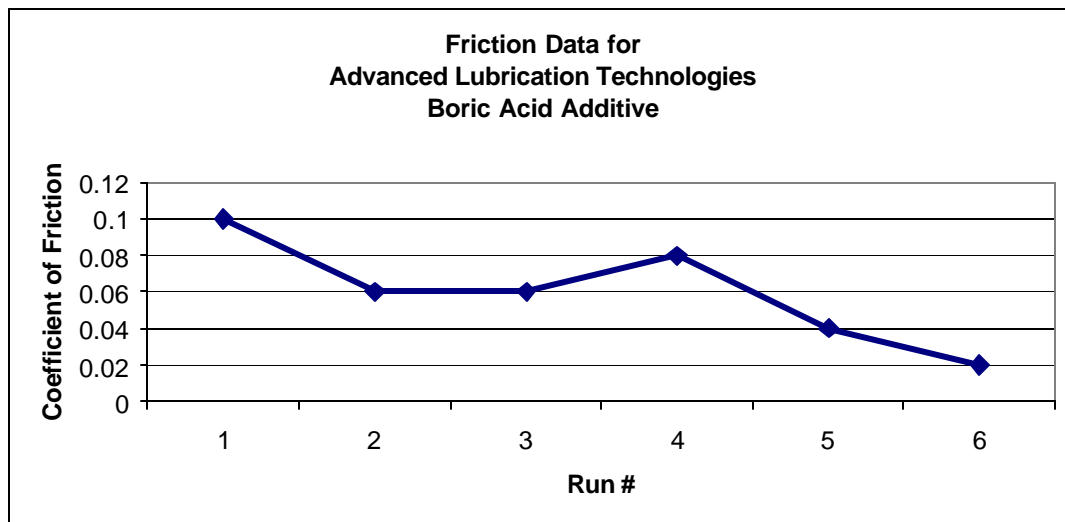
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The sixth run followed the fifth with no soak time, but was run without oil being continuously applied (drain and dry mode). Again, the pin was rotated to yield a separate scar. The intent was to see how long it would run before showing beginning indications of failure. Measurements (c/f) were taken every 15 minutes. The test was discontinued after two hours of steady performance with no signs of failure.

Respectfully Submitted,

William R. Herguth, CLS



Summary Graph of Runs  
Friction Data



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### SUMMARY OF FRICTION AND WEAR DATA

#### Test Parameters

RUN #	CONDITIONS	LOAD	SPEED	TIME	TEMP.	SPECIMENS
547A	Start of testing. Disk wetted with constant flow of oil. No pre-soak time.	Newtons = 50	Disk = 25 rpm	60 minutes	Ambient	Disk = 52100 steel, 600 random Pin = 52100 steel, 5" radius, 600 random
547B	Following first run and 2hr. soak time. Disk wetted with constant flow of oil.	Newtons = 50	Disk = 25 rpm	60 minutes	Ambient	Same disk and pin from first run, not cleaned or resurfaced. Run over same disk track and pin scar.
547C	Following second run and 2 hr. soak time. Disk wetted with constant flow of oil.	Newtons = 50	Disk = 25 rpm	60 minutes	Ambient	Same disk and pin from first run, not cleaned or resurfaced. Run over same disk track and pin scar.
547D	Following 3rd run and overnight soak time (14.25hr.). Disk wetted with constant flow of oil.	Newtons = 50	Disk = 25 rpm	60 minutes	Ambient	Same disk and pin from first run, not cleaned or resurfaced. Run over same disk track and pin scar.
547E	Following 4th run and 24 hr. soak time. Disk wetted with constant flow of oil.	Newtons = 50	Disk = 25 rpm	Constant run until steady coefficient of friction for 1hr. Run time was 2.5hr.	Ambient	Same disk and pin from first run, not cleaned or resurfaced. Disk and pin were remounted so the same disk track was used but a different pin scar was generated.
547F	Following 5th run and no soak time. Disk was removed from oil and run in "drain and dry" condition.	Newtons = 50	Disk = 25 rpm	Constant run until marked change in coefficient of friction was noted. Run time 2hr. No change.	Ambient	Same disk and pin from first run, not cleaned or resurfaced. Disk and pin were remounted so the same disk track was used but a different pin scar was generated.



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## Coefficient of Friction (f) Data

RUN #	SAMPLE DESCRIPTION	START (f)	MIDDLE (f)	END (f)	AVG. (f)	PIN SCAR DIAM. (mm)	DISK SCAR WIDTH. (mm)
547A	New formula unused Motorsilk Sample #012705 -A	0.10 – 0.11	0.09 – 0.10	0.08 – 0.09	0.10		
547B	Same	0.06 – 0.08	0.04 – 0.06	0.04 – 0.05	0.06		
547C	Same	0.06 – 0.080	0.04 – 0.07	0.04 – 0.05	0.06		
547D	Same	0.08 – 0.10	0.07 – 0.09	0.07 – 0.09	0.08	1.14	
547E	Same (Run to steady c/f – 30 minute readings)	0.03 – 0.08(strt)	0.02 – 0.04(30m)	0.01 – 0.03(60m)		1.10	
		0.01 – 0.03(90m)	0.01 – 0.03(120m)	0.01 – 0.03(150m)	0.02 at steady		
547F	Same (Drain and dry run to fail – stopped at 2hr with no change – 15 minute readings)	0.06 – 0.09	0.07 – 0.09	0.06 – 0.08		1.06	0.88ctr 2.64all
		0.05 – 0.08	0.06 – 0.08	0.06 – 0.08			
		0.06 – 0.08	0.06 – 0.08	0.07 – 0.08	0.07		

## Wear Scar Appearance

SAMPLE ID	PIN	DISK	OVERALL
724946B Runs A-D	Streaked dark gray and brown film	See run F	See Photo
724946B Run E	Streaked dark gray and brown film	See run F	See Photo
724946B Run F	Streaked dark gray and brown film	Bright medium brown film, evenly distributed in ctr with dark brown edges of equal width to ctr track	See Photo

After running the listed tests, we resurfaced the pin and disk and attempted to load and run it in the same manner as the tests with no lubricant of any kind. The last intermediate weight prior to 50N resulted in a coefficient of friction of greater than 1.0. Upon loading to 50N, extreme vibration started and fretting wear resulted within one minute of full load. The test run then failed by overloading the force sensor.

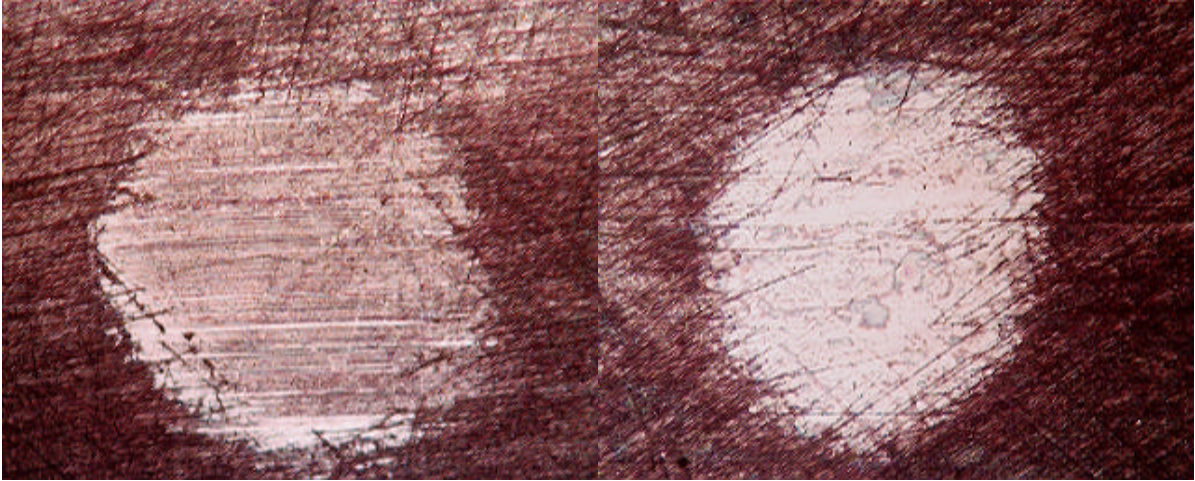


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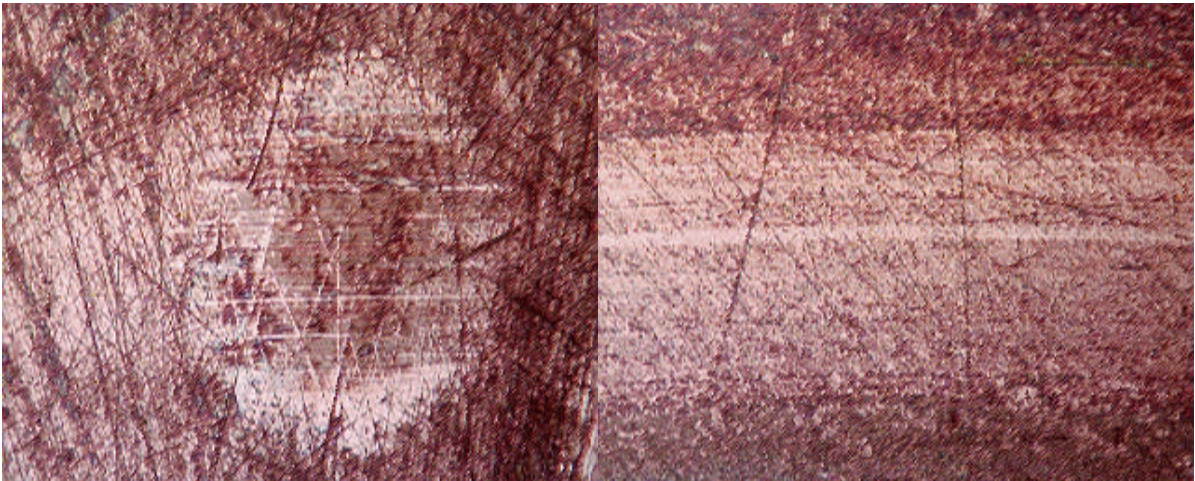
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724946B runs A - D pin at 50x

724946B pin at 50x



724946B run F pin at 50x

724946B disk track center at 50x  
following all runs

Photos of Pin and Disk After Tribometer Runs

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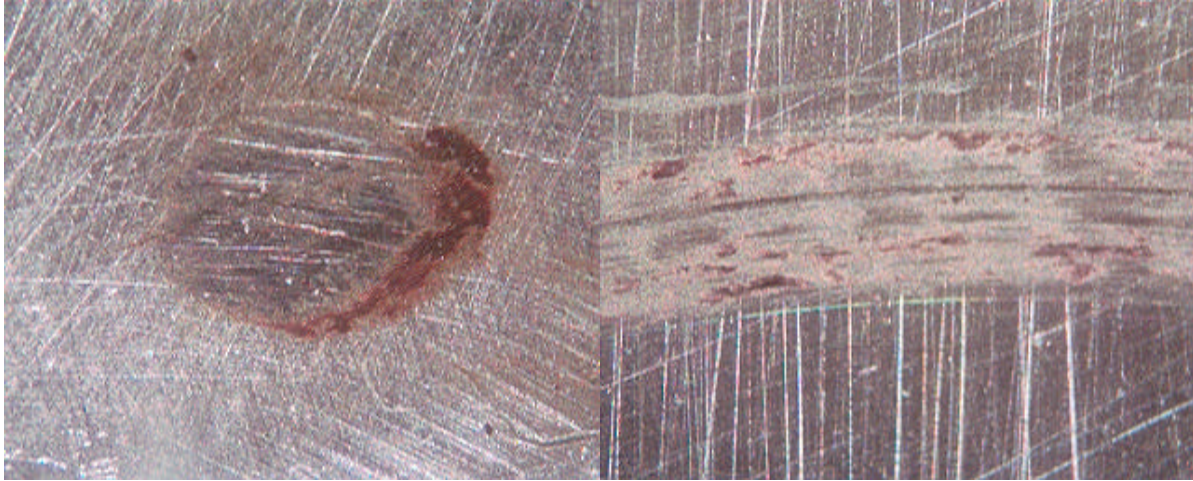


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724946B pin at 22x

724946B disk at 20x

Un-Lubricated Pin and Disk

After running the listed tests, we resurfaced the pin and disk and attempted to load and run it in the same manner as the tests with no lubricant of any kind. The last intermediate weight prior to 50N resulted in a coefficient of friction of greater than 1.0. Upon loading to 50N, extreme vibration started and fretting wear resulted within one minute of full load. The test run then failed by overloading the force sensor.

These images were taken with a stereoscopic microscope. The dark red and black deposit at the trailing edge of the pin scar is very typical of the loose iron oxide dust generated during fretting wear of steel. The track on the disk is also loaded with the deposit for the entire 360° circumference.

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